GAS!

KNOW YOUR CHEMICAL WARFARE

No. 9

CHEMICAL WARFARE REFERENCE CHART

Tactical classification	Physiological classification	USA Symbol	Name	Odor	Color and state	Persistence	Protection
CASUALTY AGENTS (Green labels)	BLISTER GASES (VESICANTS)	H	MUSTARD	Garlic, horseradish, mustard.	Liquid, slowly vaporizes	Open, 1 day; woods, 1 week to all winter.	Gas mask protective clothing, protective covers, eye shields.
		L	LEWISITE	Geraniums	do	do	Do.
		ED	ETHYLDICHLORARSINE	Biting, stinging	Liquid, evaporates like water	1 to 12 hours	Do.
		HN	NITROGEN MUSTARDS	Faint fishy odor	Solids and liquids, vaporizes at slow rate.	2 hours to days	Do.
	CHOKING GASES (LUNG IRRITANTS)	PS	CHLORPICRIN	Flypaper, licorice	Liquid, evaporates like water.	1 hour to 1 week	Gas mask.
		CG	PHOSGENE	Musty hay, green corn, ensilage.	Colorless gas	10 minutes	Do.
		DP	DIPHOSGENE	do	Colorless liquid	30 minutes	Do.
	BLOOD AND NERVE POISON	AC	HYDROCYANIC ACID	Bitter almonds	Colorless liquid, quickly vaporizes.	1 to 10 minutes	Do.
HARASSING AGENTS (Red labels)	TEAR GASES (LACRIMATORS)	CNS	CHLORACETOPHENONE SOLUTION	Flypaper	Cloud of particles, droplets	1 hour to 1 week	Do.
		CNB	CHLORACETOPHENONE TRAINING SOLUTION.	Sweet benzine odor	do	Not determined	Do.
		CN	CHLORACETOPHENONE	Apple blossom	Cloud of small, solid particles	10 minutes to weeks	Do.
		BBC	BROMBENZYLCYANIDE	Sour fruit	Liquid, slowly evaporates	Days to weeks	Do.
	VOMITING GASES (IRRITANT SMOKES)	DA	DIPHENYLCHLORARSINE	Shoe polish	White crystals	10 minutes	Do.
		DM	ADAMSITE	No odor, irritating	Yellow smoke	do	Do.
SCREENING SMOKES (Yellow labels)		HC	HC MIXTURE	Acrid	White to grey smoke	While burning	Mask in high concentration.
		FS	SULPHUR TRIOXIDE IN CHLOROSULFONIC ACID.	Acrid, choking	Dense white smoke	5–10 minutes	Gas mask.
		FM	TITANIUM TETRACHLORIDE	Acrid	White smoke	10 minutes	None needed.
		WP	WHITE PHOSPHORUS	Burning matches	Burns to white smoke in air	do	None.
INCENDIARIES (Purple labels)		TH	MAGNESIUM BOMB	None	Burns brilliant white light		
		TH	THERMATE	do	White-hot metal		None.
		IM, NP	THICKENED GASOLINE	Burning oil	Pale yellow jelly. Burns with yellow smoky flame.		Do.

Do not rely on odors alone for identification of gases. *When in doubt put on the mask.* Persistency varies markedly with weather, terrain, and method of spread. The symbols H, L, BBC, formerly HS, M-1, CA, respectively.

Gift
9 April 19[illegible]

SELF-AID REFERENCE CHART

Agent	Symbol	Symptoms	Self-aid
Blister Gases	H	No immediate symptoms. Three to 36 hours later irritation of eyes; itching, redness and blistering of skin: coughing, hoarseness, and vomiting.	*EYES*—If no pain, wash out with water. If immediately painful, squeeze OINTMENT BAL into the eye.
	L	Immediate stinging and pain of eyes and skin. Redness and blistering of the skin appear quickly.	*SKIN*—Blot, not rub, all liquid with absorbent or dry cloth which should be destroyed later. If not painful, rub on ointment protective S–461. Avoid getting S–461 in eyes. If painful, rub on ointment BAL, remove and repeat. Do not use ointments on reddened skin. As soon as possible, remove all ointments with soap and water. *CAUTION:* Liquid vaporizes from the skin, clothing, equipment, and any other objects. Therefore, turn face away and breathe as little as possible until the eyes and face are decontaminated and the gas mask is in place. Remove contaminated clothing and treat underlying skin. Clothing must be discarded or decontaminated so poisonous fumes will not contact other men.
	ED	Same as Lewisite.	
	HN	Same as Mustard.	
Choking Gases	PS	Irritation of eyes and flow of tears. Coughing and choking. Severe exposure causes nausea and vomiting. Later, pain in chest and lung edema.	Protect from further exposure by immediate application of mask. No other self-aid necessary unless breathing becomes difficult. Then keep quiet and warm until given medical attention.
	CG DP	Coughing, choking, and flow of tears. Later, difficulty in breathing and lung edema.	
Blood and Nerve Poison.	AC	Giddiness, headache, twitching, convulsions, and unconsciousness.	Immediately apply mask. If conscious and breathing, no further treatment is necessary. First-aid if unconscious, but breathing: Crush a pearl of amyl nitrite in the mask; if not breathing give artificial respiration in addition. Later, if breathing becomes difficult, keep quiet and warm until given medical attention.
Tear Gases	CNS CNB CN BBC	Irritation and watering of eyes forcing closure of lids. Heavy exposure causes irritation of the nose, throat and lungs, and produces nausea and vomiting.	Immediately apply mask. Do not rub eyes. Face upwind if unmasked. If eyes and skin burn, wash with water. Additional self-aid usually not necessary.
Vomiting Gases	DA DM	Irritation of eyes, nose, and throat. Vomiting, severe frontal headache, and temporary mental depression follow.	Immediately apply mask. Loosen clothing. Sniff chloroform. Additional self-aid usually not necessary. *CAUTION:* Do not lift mask from face except when vomiting.
Screening Smokes	HC FS FM WP	Heavy concentration irritate eyes, nose, and throat. Liquid FS and liquid FM produce acid burns. Particles of phosphorus produce heat burns.	If smoke is irritating, apply mask. If eyes and skin burn, wash with water. The possibility of smoke screening poisonous gases must be kept in mind. White phosphorous particles must be kept wet until removed. Immerse in water or cover burn with a cloth soaked with water. Where available, a solution of copper sulfate should be used instead of water. Do not use grease or salve.
Incendiaries	TH (Magnesium) TH (Thermate) IM NP	Heat burns	Cool the burning material by flooding with water and remove. Treat the burn like any other heat burn.

SELF-AID IS THE INDIVIDUAL RESPONSIBILITY OF ALL RANKS. CARE FOR YOURSELF INSTANTLY ON EXPOSURE. DO NOT EXPECT OR WAIT FOR HELP FROM OTHERS. SPEED IS ESSENTIAL. EACH SECOND LOST INCREASES THE FINAL DAMAGE.

TABLE OF CONTENTS

PREFACE

By means of this pamphlet the individual can learn how to take care of himself in any gas attack. This pamphlet contains six lectures in Chemical Warfare covering the rudiments of gas identification, personal protection, matériel and tactics, and decontamination.

Using discussion, line drawings, and charts, the pamphlet presents the important principles of defense; and briefly, offensive measures in Chemical Warfare.

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CHEMICAL WARFARE AGENTS

Foreword.—If a person is to understand chemical warfare clearly, it is essential that he have a thorough knowledge of the chemical agents that are employed. We want you to have a respect for, but not a fear of chemical warfare.

"Chemical agent" means a substance useful in war which, by its ordinary and direct chemical action, produces a significant body injury, a screening smoke, or an incendiary action. What we in the Navy are chiefly concerned with in chemical warfare are those agents which produce a powerful physiological effect on contact with the body.

Classification of Agents.

Agents may be considered from two general standpoints:

1. **Tactical**—or the way the agents are used in the field.
2. **Physiological**—or the effect the agents have on an individual.

Under the *tactical classification*, four groups are listed:

A. *Casualty agents*—designated on munitions by green bands.
B. *Harassing agents*—designated by red bands.
C. *Screening smokes*—designated by yellow bands.
D. *Incendiary agents*—designated by purple bands.

Casualty agents are materials of such chemical and physical characteristics that a dangerous or killing concentration can be set up under ordinary field conditions.

Harassing agents are any agents used to force masking and retard military operations.

Screening smokes are substances which, when burned, produce a dense, obscuring smoke.

Incendiary agents are materials which generate sufficient heat to cause the ignition of combustible substances with which the agent comes in contact.

Physiologically, these agents are classified as:

A. Casualty agents.
B. Harassing agents.

Casualty agents include the blister gases, choking gases, and blood and nerve poisons. The harassing agents include the tear gases, and vomiting gases.

Blister gases (*vesicants*).—Chemical substances which are readily absorbed or dissolved on the exterior and in the interior parts of the human body, and are followed by the production of pains, burns, and blisters.

Choking gases (*lung irritants*).—Chemical agents which when breathed cause inflammation and irritation of the nose, throat, windpipe, and lungs.

Tear gases (*lacrimators*).—Irritants that cause temporary eye irritation and produce a copious flow of tears. Also may irritate the skin.

Vomiting gas (*sternutators*).—Irritants which, when breathed in extremely low concentrations, cause coughing, sneezing, headache, pain in the nose and about the teeth, followed by nausea and temporary physical weakness.

Blood and nerve poisons (*systemic poisons*).—Substances which directly affect the heart action and nerve reflexes, or interfere with absorption and assimilation of oxygen by the body.

History of War Gases

Choking gases.

Chlorine.—Here is a very brief history of the development of war gases. The choking gas (lung irritant) *chlorine* was the first war gas used during the World War I. It was introduced by the Germans against the Allies on April 22, 1915. Although warned by the Germans of the coming poison gas attack, the Allies were caught by surprise and suffered heavily. Of the 20,000 casualties, 5,000 proved fatal. Later in the war, when troops were protected with gas masks, the effectiveness of chlorine was greatly reduced. Today chlorine, which is a heavy greenish-yellow gas, is not considered as a good war gas because of its low toxicity and its great chemical activity which makes it very easy to protect against. Its principal importance relates chiefly to the manufacture of other war gases.

Phosgene and diphosgene.—The only American gas in American munitions used during the last war was *phosgene.* Phosgene is also a choking gas (lung irritant), and has an odor which is described variously as that of ensilage, green corn, or green apples. It is 9 to 10 times more toxic than chlorine, affecting the lower part of the lungs rather than the respiratory tract. Another choking gas, *diphosgene* (DP), is more persistent than phosgene, and is favored by the Germans. The Germans used this gas in the last war and have a large supply on hand now to employ in the event chemical warfare breaks out.

Chlorpicrin.—Still another choking gas (lung irritant) is *chlorpicrin* (PS). This agent, in addition to its choking action, causes some lacrimation, nausea, and vomiting. For this reason, it has often been called "vomiting gas" or "puke stuff." Pure chlorpicrin is a nearly colorless liquid differing little from water in appearance, though slightly oily. The odor is sweetish and resembles that of flypaper. Although chlorpicrin (PS) is considerably more persistent, it is less toxic than phosgene. Its greatest advantage lies in its high chemical stability which makes it more difficult to protect against than many agents.

Vomiting gases.

Diphenylchlorarsine and Adamsite.—By the summer of 1917, the gas masks of the belligerents had been developed to such a degree that they furnished adequate protection against the choking gases. The choking gases employed during the war were slow in acting, and did not incapacitate until several hours after exposure. The problem was, therefore, to find a quick-acting, more persistent gas that would penetrate the masks. The vomiting gas, *diphenylchlorarsine* (DA), was the German solution. Diphenylchlorarsine was dispersed in the form of a fine dust, the vapor of which was not readily adsorbed by the charcoal in the gas mask canister. When these dust particles were inhaled, they caused sneezing, followed by violent headaches, nausea, and physical weakness. While this irritant smoke produced few serious casualties its most damaging effect was indirect. The soldier became nauseated and was forced to vomit. Upon removing his mask he fell victim to the choking gases which were released simultaneously.

Another vomiting gas is *Adamsite* (DM). This agent is chemically known as diphenylaminechlorarsine. In World War I, it was not actually used at the front. It possesses properties similar to those of DA. Adamsite, when pure, is a bright canary-colored, crystalline solid and practically odorless. However, when dispersed as a smoke, it forms a bright yellow cloud with a characteristic smoky odor.

Mustard, Lewisite, and other blister gases.

With the addition of a mechanical filter to remove such toxic particles from the contaminated air, the gas mask provided adequate protection against the vomiting gases (irritant smokes) as well as the choking gases (lung irritants). Therefore, some agent against which the mask alone would not give sufficient protection was desired. This was found to be *mustard gas* (H), which, during World War I became the most important chemical warfare agent because of its wide use and the difficulty of protecting against its effects. Mustard gas and the other blister gases (Lewisite (L) and ethyldichlorarsine) attack any part of the body with which the vapor or liquid comes in contact, causing serious burns and blisters. There is no pain connected with the exposure to mustard, and symptoms may be delayed from 4 to 24 hours. This type of agent is thus insidious in its action and extremely difficult to guard against, since the ordinary uniform affords little, if any, protection. For further protection against blister gases in the present war, special types of protective clothing have been designed, which are available to all exposed personnel aboard ships and to those likely to be exposed at shore stations.

Mustard gas is not only a strong blistering gas but also a powerful choking gas. Unlike chlorine and phosgene its does not affect only the lungs, but attacks the whole respiratory system. This "Hun Stuff"

or "Hot Stuff" as it was called by the troops in the last war, is a heavy, dark, oily liquid and has an odor similar to that of garlic or horseradish. It freezes at a relatively high temperature (46°–50° F.). However, upon being mixed with Lewisite, another blister gas, the freezing point of mustard is considerably lowered, thereby making it possible to disperse mustard from airplanes. This method of disseminating chemical agents has been found to be very effective and undoubtedly will be used against ships at sea, should chemical warfare break out.

While Lewisite is not as persistent as mustard, it possesses several outstanding characteristics. Lewisite causes immediate irritation of the eyes, while the skin shows slight irritation in 15 minutes. In addition, arsenic poisoning of the blood stream may result from exposure to Lewisite.

Lewisite itself is a colorless or slightly-yellow liquid and has an odor of geraniums. It freezes at 0° F., and, since water readily destroys the blistering properties of liquid Lewisite, the chief usefulness of this agent is under conditions that minimize hydrolysis; that is, in cold weather or in hot, dry areas. Nonetheless, contaminated areas remain dangerous for long periods, as one of the hydrolysis products, Lewisite-oxide, is a solid, blister agent, and very toxic. However, since it does not evaporate, there is little danger of getting burned unless the skin comes in direct contact with the Lewisite oxide.

A blister gas which was used to a slight extent in the last war was *ethyldichlorarsine* (ED). This agent is not only less persistent than either mustard or Lewisite, but also less blistering in its action. It causes paralysis of the fingers and vomiting. It is recognized in the field by its stinging or biting odor.

Nitrogen mustards.—Up to the present time, the presence of war gases could be detected by their characteristic odors. Now, however, very potent chemical agents have been developed which have little or no odor even when present in high concentrations. These agents are called the *nitrogen mustards* (HN), and are very blistering in their action. However, their main physiological effect is on the eyes. A drop of liquid in the eye will cause redness, swelling, ulceration, and blindness. The relatively faint odor is recognized as "fishy," and the agent acts in 15 minutes.

Blood and nerve poison.

Hydrocyanic acid gas.—*Hydrocyanic acid* (AC), a typical blood and nerve poison, had a very limited use in World War I, but has definite future possibilities in this war. It causes collapse and unconsciousness from systemic poisoning. AC is a colorless liquid that quickly vaporizes. Its odor in field concentrations is similar to bitter almonds. Speed cannot be stressed too much in the treatment for this gas.

Tear gases.

Although tear gases were used throughout the first World War, their employment became more and more limited as other more powerful gases were introduced. However, owing to their effectiveness in low concentrations, forcing troops to mask, tear gases served a useful purpose. The principal tear gases now in use are *chloracetophenone* (CN), a solid, and its two solutions CNB and CNS. CNB, which is a mixture of chloracetophenone, benzene, and carbon tetrachloride, is used primarily in training troops. CNS, which is a mixture of chloracetophenone, chlorpicrin, and chloroform, because of its greater lacrimatory and skin effects, is to be employed if chemical warfare breaks out. However, since CNS is nonpersistent, there is little possibility of this agent being used against ships, although against shore stations, it would be very effective. The use of solid chloracetophenone (CN) mixed with AP shells against ships at sea appears very probable, since this would tend to hinder any repair parties that might be at work. *Brombenzylcyanide* (BBC) is a tear gas which is used and favored by the British. Its chief disadvantages are corrosive actions and the expense involved in manufacture.

Screening smokes.

The only chemical warfare agents which actually have been employed and which are of practical value at the present time, are those which produce smoke. There are many ways of dispersing smoke, depending upon the nature of the material. Smoke may be broken up and scattered by explosion, by heat to vaporize the material, or even by spraying the smoke into the air. The latter method is used to a greater extent by the Navy. The smoke mixture used is *sulfur trioxide* in *chlorosulfonic acid* (FS). This is carried aboard ship in two generators, one port and one starboard, at the stern. Each generator consists of four tanks, each tank containing 32 gallons of the FS mixture. FS is released by air pressure, and on combining with the moisture in the atmosphere, produces a white smoke. FS is used instead of another smoke, FM (*titanium tetrachloride*) for several reasons. Among other things, the cost is less than that of FM, and the obscuring power is somewhat better. HC smoke pots are a different type of smoke munition utilized by the Navy. They are made in two designs, floating and non-floating, and may be used on shore installations or dropped off boats into the water at sea to set up a shielding smoke screen. The smoke is produced by the burning of a mixture of solid powdered chemicals.

The Army uses *white phosphorus* (WP). It not only produces a good smoke, but is also a fair incendiary and a good casualty agent. WP in explosive shells or air bombs is an effective incendiary against

grass, woods, and buildings of light wood structure. However, a WP fire is easily extinguished through the use of water.

Incendiaries.

For materials which require higher temperatures to ignite, special incendiary agents are employed. The two main incendiaries in use now are (1) *magnesium* (Mg) case bombs and (2) *thermate* (TH) bombs. The magnesium case bomb burns at a temperature of 3,630° F, and the addition of water only tends to increase the intensity of the fire, since it supplies oxygen. This type of bomb burns from 10 to 15 minutes. During combustion, the hot molten magnesium spatters, spreading the fire.

The thermate bomb is not often encountered because used alone as an incendiary it has limited value due to the small area covered by the charge. The thermate bomb is merely a container of thermite, which is iron oxide and aluminum, and burns at a high temperature of 4,300° F. This temperature is sufficient to melt through iron or steel and ignite any combustible materials in the vicinity, but it does not spread out over a wide area, and burns for only a very brief period of time. One of its main uses is the destruction of field artillery and equipment to prevent its being captured by the enemy.

Summary.

For a quick summary, let us review the physiological classification of the principal chemical warfare agents. First are the choking gases: chlorine (Cl), phosgene (CG), diphosgene (DP), chlorpicrin (PS). Of these four, phosgene, diphosgene, and chlorpicrin are the most important. Second come the vomiting gases: diphenylchlorarsine (DA) and Adamsite (DM) being the most widely used. The blister gases are those against which the gas mask alone does not give adequate protection because parts of the body other than face, eyes, and lungs may be affected. The important blister gases are mustard (H), Lewisite (L), and to a lesser extent, ethyldichlorarsine (ED), and the nitrogen mustards (HN). Tear gases, merely harassing agents, are chloracetophenone (CN), and its two solution forms, CNS and CNB. The chief British tear gas is brombenzylcyanide (BBC). Screening smokes, solid HC, and FS and FM (both liquids) are used chiefly by the Navy; while white phosphorus (WP), a solid, is a favorite of the Army. The principal incendiary agents are magnesium and thermate (TH).

There are other chemical warfare agents that may be used, and more are being developed each year, but the above list gives the most important ones for each classification, and should furnish an adequate introduction to the type of agents chemical warfare employs.

SELF-AID

Defense against gas.

Good gas defense demands fearless action, the best possible use of our protective equipment, and prompt self-aid. Some men are afraid of gas because they know too little about it. Gas is not as horrible as enemy propaganda and thrill writers would have us believe. Certainly gas is no more barbarous than cold steel. A gas that produces a blister which heals is not as bad as a piece of shrapnel which tears and disfigures the body. A gas that produces difficulty in breathing is not as dangerous as a bayonet thrust through the abdomen. Gas, which in the last war produced fewer than 2 deaths per 100 casualties, is less to be feared than high explosive bombs.

Although gas should not be feared, it must be respected because it can produce many casualties when used against men who do not know how to defend against it. Our gas injuries in the last war required a total of 2,947,199 days hospitalization. In other words, the equivalent of almost 3,000,000 men were knocked out of battle for a single day, or a force of 1,000 men were unable to fight for a whole month. Such a circumstance might mean the loss of an important battle. As the last war progressed, however, gas protection improved, gas discipline became routine, self-aid was taught each man, and the number injured decreased.

If we are able to answer the following questions we should have no fear of gas warfare.

> DO I KNOW ENOUGH ABOUT MY PROTECTIVE EQUIPMENT AND HOW TO USE IT, SO AS TO PREVENT GAS FROM REACHING MY BODY?
>
> DO I KNOW ENOUGH ABOUT SELF-AID SO THAT I CAN TREAT MYSELF IF CONTAMINATED BY GAS?

Our equipment, the best in existence, has been tested against every known war gas. It has been tried in cold, dry climates, in hot, wet weather, in rain and snow, and under conditions similar to those of battle. Our gas mask not only protects the eyes and face, it also removes gas from the air we breathe, preventing injury to the nose, mouth, throat, and lungs. The goggles shield the eyes, which are so easily injured by liquid gas. The protective clothing and ointments prevent the gas from reaching the skin, where it may produce burns and blisters. The object of our antigas training is to make us able to use this equipment for the best protection.

Antigas training also acquaints us with the effects of the various gases on our body and teaches us what to do for ourselves when we are exposed to them. Blister gases injure the eyes, burn and blister the skin, and when inhaled damage the nose, throat, windpipe, and lungs. When absorbed by the body they are poisonous. They are:

1. MUSTARD GAS
2. LEWISITE GAS
3. NITROGEN MUSTARD GAS
4. MIXTURE OF GASES

These gases are injurious either as vapors or as liquids. They can penetrate uniforms, boots, shoes, or any other objects not specially treated to make them gasproof. The liquid evaporates and produces fumes which are poisonous. Thus, men contaminated with blister gases, can carry and spread them to other clean men and places. The wind, blowing across areas contaminated with the liquid, carries the poisonous fumes which affect men in the direction of the wind.

Mustard gas is more damaging to the eyes than to the skin or the lungs. It is very insidious in its action because it does not produce bad effects for some time after it touches the body. Therefore, injury is often produced hours before contamination is suspected.

The damage produced by mustard vapor depends on the amount of the vapor in the air and the length of time one is exposed to it. The first effects that might be noticed usually do not appear for from 2 to 24 hours after exposure. These include a feeling of grit in the eyes, a slight cough and hoarseness and itching and redness of the skin similar to that produced by ordinary sunburn. With mild burns, the redness increases during the first 24 hours and then gradually fades. With more severe burns, blisters appear, especially in the moist regions of the body such as the armpits, and on the bends of the elbows and knees, the neck, the groin, and the sex organs.

Upon detection of mustard vapor, instantly put on the gas mask to protect the eyes, face, and lungs. The itching of the skin may be relieved by gentle bathing with soap and water, and by applying calamine lotion where available. The clothing should be removed as soon as battle conditions permit; it must be decontaminated or discarded so that poisonous fumes will not reach other men. If the eyes and skin become worse, report to the corpsman.

Liquid mustard, like the vapor, usually is painless for hours. Battle conditions permitting, each man upon contamination will *instantly carry out all the self-decontamination procedures exactly in the following order:*

Liquid mustard evaporates from the skin, clothing, equipment, and any other objects. Therefore, turn the face away, and breathe as

little as possible until the eyes and face are decontaminated, and the mask is in place.

When the eye shield has not been worn, wash out the eyes at once. Hold the lids open with the fingers, and pour clean water into one eye, and then into the other. This must be done immediately after exposure; a delay of 2 minutes may result in blindness. Washing should last at least 30 seconds, and no longer than 2 minutes. It is better to use too much water than too little. If water is not available use urine.

All visible liquid mustard on the face is then blotted with the blotting paper about the tube of ointment, or a clean cloth. Fresh pieces of cloth must be used for each drop of liquid, and they must be burned, or buried after using. The face, ears, and neck are then coated with Navy ointment S–461, rubbing it into the skin for 20 to 30 seconds. Ointment S–461 should be kept out of the eyes, since it injures them. It is very important to remove all liquid drops of mustard before putting on the mask, since such drops under the mask are very dangerous because the vapor from them will be inhaled.

The next step is to put on the mask. It should be on the face within 3 to 4 minutes at the latest after exposure. With the mask in place, the eyes, face, nose, mouth, throat, and lungs are protected from further exposure to the gas.

It is now necessary to decontaminate all other exposed skin of the body by covering and rubbing with ointment S–461. This should be done whether or not actual drops of mustard can be seen.

Next, the clothing should be taken care of, because drops of liquid on the untreated clothing will penetrate to the skin beneath and produce damage. If battle conditions permit, it is best to remove all clothing and to spread ointment on all areas of the skin which may be contaminated. If battle conditions prevent taking off all the clothes, then tear out or cut out those parts that are wet with the liquid mustard. Then cover the contaminated areas with ointment S–461, and remove clothing as soon as possible, and bathe all contaminated parts. It is best to wash the entire body with soap and water. The clothing removed must be decontaminated, disposed of, or destroyed, since its contained mustard continues to give off fumes which contaminate surrounding objects. This is very dangerous in closed spaces where high concentrations of the fumes can be built up.

There may be times when you find yourself without ointment. In such case wash the skin with soap and water, with urine, or with gasoline, kerosene, or alcohol. These should be applied very carefully, for attempts to remove mustard by a flushing action may spread the blister gas over a large area and cause a more extensive burn. It is best to wet cloths with the fluid and stroke inwards towards the center of

contamination. These cloths must be disposed of by burning or burying.

If all these steps are carried out exactly as outlined within 5 minutes at the most, there is nothing to fear from mustard gas. You are able to carry on with your job. Should there be a delay in treating yourself, and if the skin is already red, ointments or fluids must not be used. Then the only self-aid is to gently bathe the skin with soap and water, and where available apply calamine lotion to lessen the itching. If further irritation should develop, get help from a corpsman.

Lewisite.

Lewisite, like mustard, injures the eyes, skin, and lungs, but unlike mustard, Lewisite produces a stinging pain in 10 to 30 seconds after touching the body. The stinging keeps increasing as the Lewisite penetrates, and in a few seconds becomes a deep aching pain.

Even in low concentrations the vapor of Lewisite immediately irritates the eyes and the breathing passages, forcing the wearing of the mask. Because of this warning and protection, eye and lung damage from the vapor are less apt to occur than in the case of mustard vapor. If irritation and pain begin immediately after exposure, then self-aid must be given by applying ointment BAL to the eyes and to the skin.

Self-aid for liquid Lewisite is the same as for liquid mustard except that ointment BAL is used for decontamination of both the eyes and the skin. Since Lewisite in the eyes causes immediate sharp pain, you may have to pull open the lids with the fingers in order to get ointment BAL into the eye. Squeeze the BAL directly into the injured eye, also onto the lids, and gently massage them. If the eye cannot be opened because of the pain, apply the ointment to the slit between the lids, and rub it in as well as possible. As soon as the pain lessens and the lids can be pulled apart, squeeze additional ointment BAL into the eyes.

BAL itself causes a sharp stinging pain and a flow of tears in an uninjured eye lasting for about 20 minutes. Even so, however, it lessens the pain due to Lewisite, stops the deleterious action, and saves the eye.

The next important step in self-aid for Lewisite is to decontaminate the hands, face, ears, and neck by blotting off the liquid as quickly as possible and squeezing ointment BAL from the tube on the fingers, and spreading in a thin layer over the skin. It is rubbed in gently and allowed to remain for about 5 minutes, after which the excess is wiped off. The gas mask is then put on. We are now ready to decontaminate the rest of the body. All exposed skin should be covered and rubbed with ointment BAL. If battle conditions permit, the contaminated clothing should be removed and the skin beneath

treated with BAL. The clothing must be cared for so that poisonous fumes from the liquid it contains will not harm others.

The BAL should remain on the skin for at least 5 minutes. The excess may then be wiped off. To decontaminate large splashes, the application and removal of BAL may be repeated two or three times. The last application may remain on the skin for 2 hours, and then be removed with soap and water.

Nitrogen mustard and mixtures of gases.

The self-aid for nitrogen mustard gas is the same as for mustard gas. Protective ointment S–461, however, is not as good a skin decontaminant for this gas as for mustard. Therefore, bathing with soap and water, or even water alone must be accomplished as soon as possible after exposure.

Thus far we have considered only pure forms of the blister gases. It is highly probable, however, that mixtures of these blister gases will be used in modern warfare. Such mixtures do not produce more severe lesions than either gas alone, but they make it difficult to determine what kind of gas is present. Where there is doubt as to the kind of gas mixture used, we must assume possible contamination with mustard and lewisite, and carry out decontamination for both gases. Self-aid therefore, includes immediate washing of the eyes with water and the use of BAL ointment, as for Lewisite. Self-aid of the skin demands application of ointment S–461 as for mustard, and ointment BAL as for Lewisite.

Now let us consider the gases which injure the lungs. The more important of these gases are:

1. PHOSGENE
2. DIPHOSGENE
3. CHLORPICRIN
4. CHLORINE

They are generally known as choking gases because that is what they do. They are so irritating to the nose, throat, windpipe, and lungs that they produce coughing, choking, and a feeling of tightness in the chest. They also cause a flow of tears from the eyes. In addition, chlorpicrin burns the eyes and skin. The important point to remember in the case of all these gases is that the gas mask protects. Instantly upon detection, hold the breath, put on the mask, and breathe out as completely as possible. The mask protects you from further exposure, and represents the principal defense. Other than this, there is little we might do for ourselves. We must carry on unless breathing becomes difficult, which may occur 2 to 24 hours after exposure. This delay in effects is one of the bad features of these choking gases. A man may be exposed, yet feel perfectly fine except

for a slight dryness of the throat. Hours later, however, he begins to cough, choke, feel a pain in his chest, and find it difficult to breathe. Now is the time for him to rest as much as possible, and to keep warm until help arrives. Not every gassed man, however, has this experience. Even though he coughed and choked when first exposed, he applied his mask, kept it on during the gas attack, and finished his job without further trouble. Regardless of the bad effects first produced, therefore, we should not dread the possibility that sickness will develop later on, because it may never occur.

Self-aid for vomiting and tear gases.

The vomiting gases and tear gases make one sick even though only a small amount is in the air, but they do not produce serious injury. The use of these gases is mainly to harass, to force the wearing of the mask for long periods, thereby making us less able to fight. They also tempt a man to unmask in the belief that his mask is leaking, and so make a following attack with highly poisonous gas more effective.

The vomiting gases commonly take the form of irritant smokes. These gases are irritating and painful to the inside of the nose, and produce sneezing. They burn and pain the throat and windpipe, also produce a feeling of grittiness in the eyes, an aching of the teeth and gums, a sense of tightness in the chest, watering of the eyes, running of the nose, and vomiting. These results do not come on for several minutes after the presence of the gas is suspected. Even if the gas mask is put on right away, the pain in the nose and other bad effects may increase for a few minutes before they begin to disappear. Unless men are trained to expect this, they may believe that the mask leaks, remove it, and be further exposed.

Self-aid consists of putting on the mask and keeping it on in spite of unpleasant sensations. During bouts of vomiting, the mask may be lifted temporarily from the face so as to keep it free of fluid. Sniffing fumes of chloroform gives some relief. A doctor's help is seldom necessary for exposure to vomiting gases. Their effects disappear quickly, usually within an hour or two.

Tear gases produce strong stinging of the eyes, causing a marked flow of tears. In hot climates they also irritate the nose, throat, and skin. Self-aid for these effects is mainly facing upwind, allowing the tears to dissolve, and washing the gas out of the eyes, and putting on the gas mask.

The eyes should not be rubbed because there is great danger of further contaminating them. The stinging of the skin may be relieved by washing with water. The effects of the tear gases wear off quite quickly.

Self-aid for nerve poisons.—We now come to the gases known as nerve poisons. The important self-aid to remember in this case is that the mask must be put on as soon as the gas is detected. For self-aid the fumes of amyl nitrite should be inhaled. As for first aid to others, if the casualty is unconscious, shove a crushed pearl of amyl nitrite under the mask and, if breathing has stopped, give artificial respiration in addition.

Self-aid for screening smokes.

Some of the screening smokes, although not toxic in concentrations used at sea, may be irritating but not dangerous. When white phosphorus is used as a screening smoke, particles of the phosphorous burn when they touch the body. The burning areas should be placed under water, or covered by cloth wetted with water, urine, saliva, or any other nonirritant and noninflammable solution. Wet earth can even be used. Copper sulfate solution where available, is preferred above anything else, since it coats the particles of WP, and makes them painless. The particles must be removed. Grease, oil, or salves should not be employed because they dissolve the phosphorus and make a systemic poison.

Summary

In summary, we are now prepared to answer the questions originally stated. There is nothing to fear about gas warfare, providing we use our protective equipment to prevent the gas from reaching our body, and providing we give ourselves prompt aid when contaminated.

Remember always that "an ounce of prevention is worth a pound of cure." Therefore, take care of your equipment, keep it handy and know how to use it so that it will protect you when needed.

Remember that the gas mask is the most important part of your antigas equipment. Learn how to get it on quickly. Remember that washing with soap and water, or even with water alone is always a good and safe practice; that ointment S–461 is for mustard gas and ointment BAL for Lewisite gas.

Remember that on contamination by any gas, self-aid, or what you do for yourself, is most important. There is not time to wait for help from others before protecting yourself, or before decontaminating yourself, since gas attacks the body in a matter of seconds.

Self-aid includes all the protective measures an individual can take for himself. Self-aid is the responsibility of each man of all ranks. When done early, it is the best form of treatment. No one must wait for help from others. Speed is essential. Each second's delay increases the damage.

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SELF-AID FOR CHEMICAL WARFARE AGENTS

1. Liquid mustard or nitrogen mustard in the eye.

(a) Rinse eyes immediately with water from the canteen. Continue for from 30 seconds to two minutes.

(b) Put on gas mask after decontaminating face with ointment S–461.

2. Vapors of mustard or nitrogen mustards.

(a) Washing of eyes and skin is of no value.

(b) Put on gas mask.

3. Liquid Lewisite and vapor in the eye.

(a) Put ointment BAL into the eyes and on the lids.

(b) Put on gas mask after decontaminating face with ointment BAL.

4. Liquid mustard on the skin.

(a) Blot, not rub, all visible liquid from exposed skin.

(b) Apply ointment S–461 to contaminated areas. Rub in for 20 to 30 seconds. Wipe or wash off excess ointment. Repeat once.

(c) Remove and dispose of contaminated clothes.

(d) Decontaminate underlying skin with ointment S–461.

(e) Wash with soap and water. Take a bath if possible.

(f) After skin redness has developed, omit ointment. Use only soap and water.

5. Liquid Lewisite on the skin.

(a) Ointment BAL should be substituted for S–461 in the procedure described for liquid mustard on the skin.

If a liquid chemical agent gets into the eye or on the skin but there is no immediate pain, assume that it is mustard. If, however, immediate severe pain, assume that it is Lewisite.

6. Choking gas.

(a) Hold breath until gas mask is on.

(b) Carry on, unless breathing becomes difficult; then get medical aid.

7. Tear gas.

(a) Put on mask.

(b) Wash eyes and skin with water if burning continues.

8. Vomiting gas.

(a) Put on mask and keep it on even though distress increases for several minutes.

(b) Whiffs of chloroform relieve headache and pain in nose and throat.

9. Screening smokes.

(a) Keep burned part immersed in water or covered with a wet cloth until burning particles are removed.

(b) Cover with copper sulfate solution when available.

(c) Do not use oil or grease.

10. Nerve poisons.

(a) Hold breath until gas mask is on.

(b) Sniff fumes from a crushed pearl of amyl nitrite.

(c) Slip a crushed pearl of amyl nitrite under the mask of any shipmate who is unconscious or in convulsions. If he has stopped breathing, give him artificial respiration to make him inhale the nitrite fumes.

NAVY GAS MASK DRILL

A gas mask drill is an established routine designed to instruct an individual to put on his mask and gain protection from chemical agents as quickly and easily as possible. It is important to learn the drill carefully, in order to avoid unnecessary motions. Once a drill is learned, it is not forgotten, and a person will be able to protect himself from war chemicals by force of habit almost without thinking, as soon as the alarm is given. All drills are given "at ease."

The drill.—The new Navy drill was recently developed by Capt. M. A. Leahy, U. S. N. (Ret.), at Edgewood Arsenal. It is for the ND Mk. III, IV, and NDO Mk. I masks. It has been adopted by the Navy and also by the Coast Guard, Marine Corps, and the Army for use with all masks with the canister at the rear of the head.

For instructional purposes, the drill is performed "by the numbers," so that each step may be learned carefully in the correct order. In an actual gas attack, the mask is put on in exactly the same way except that nobody waits for the separate numbers to be called out. In donning the mask "by the numbers," it requires *four* counts to place the mask on the face and in operation.

For drill by the numbers, the command is: "By the Numbers, **GAS.**" At the command **GAS,** dispose of arms and loose equipment. Remove and dispose of head covering. (Pass the head or chin strap of head covering over the right arm. Soft caps are disposed of by placing

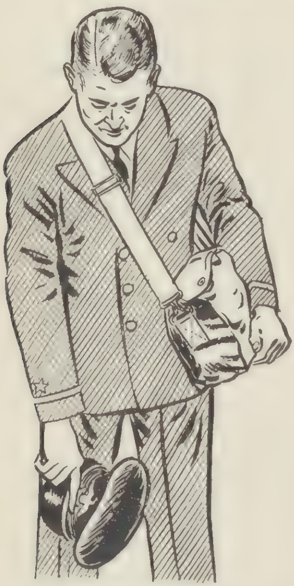


FIGURE 1.—Headgear disposed of.

FIGURE 2.—Carrier opened.

Carrier brought around to front of body from left hip.

FIGURE 3.—Mask removed from carrier with right hand by grasping diaphragm assembly with outlet valve between first and middle fingers.

FIGURE 4.—Overhand grasp on canister with left hand.

FIGURE 5.—Facepiece released from right hand.

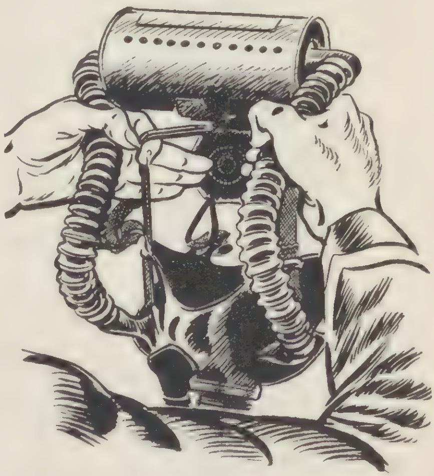


FIGURE 6.—Hoses and lower head harness straps encircled by thumb and first finger of each hand. Head pad raised by remaining fingers extended.

under the belt or in the pocket. Be careful not to let the head piece touch the ground, where it might become contaminated.) With the left hand, slide the carrier forward in front of left hip. Hold it at bottom with the left hand, and open flaps with the right hand. Remove the mask with the right hand by grasping diaphragm assembly and withdrawing up. The outlet valve should be to the front, away from the body. With the left hand, thumb underneath in an overhand grasp, hold the canister on the left side of the head pad. Still retaining grip on canister with the left hand, allow the facepiece to fall forward. With the thumb and index finger of the right hand, encircle hose and lower head harness strap together on right side as close to the canister as possible; do the same on left side with left hand. By keeping the grip as close to the canister as possible, more room is given for the face to enter the mask. Extend the lower three fingers of each hand to thrust the canister pad upward, maintaining grasp on hose and lower head harness strap with thumbs and index fingers. Raise mask face high; thrust chin forward.

TWO. Seat facepiece firmly on chin and move canister and head harness into place with an upward, backward sweep of the hands. Seat head harness with canister pad at center back of head; fit mask to face by smoothing out edges of the facepiece from bottom to top. Be sure head harness straps are not twisted and that the ends of the straps are not caught anywhere on the mask.

FIGURE 7.—Mask being seated on chin and drawn up on to face.

FIGURE 8.—Mask seated on face. Clearing facepiece.

FIGURE 9.—Testing fit of mask.

FIGURE 10.—Headgear returned to head. Carrier closed and replaced to rear of left hip.

THREE. Close outlet valve with two fingers of the right hand, or press the valve against the chin with the thumb and first two fingers of either hand and exhale vigorously. This action clears the facepiece of any contaminated air that might be present, and is called "Clearing the Mask." Next, pinch the walls of the hose tubes together between the canister and the facepiece as close as possible to the canister in order to close off all passage of air from the canister. Inhale. This tests the fit of the mask against the face. The facepiece should collapse, and no air should enter.

FOUR. Replace head gear. Fold inner carrier flaps in and fasten the outside flap. Replace carrier to original position at rear of left hip, thus completing the first part of the gas mask drill.

The second part of the drill is removing and replacing the mask. For instructional purposes this is also done "by the numbers." The command is, "By the Numbers, Remove and Replace **MASK.**" First, **TEST FOR GAS:** Take a moderately full breath, exhale part of the air breathed, and stop breathing. Stoop to bring the face as close to the ground as possible without touching any part of the person or equipment, other than the feet, on the ground. Grasp the lower head harness tab on the side of mask and pull facepiece slightly away from the face to break the seal against the face. Sniff gently but do not inhale deeply. Resume the erect position. Clear the mask as previously described. If no gas is detected, continue to remove mask.

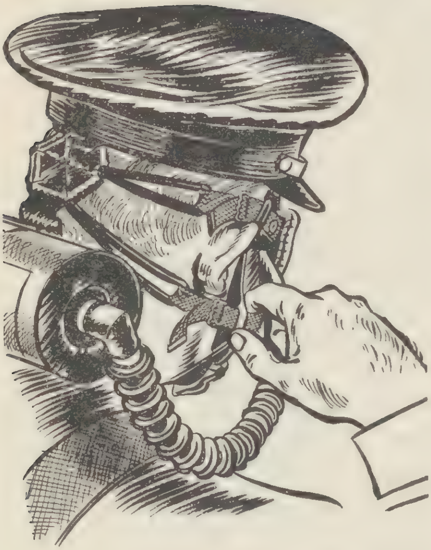


FIGURE 11.—Testing for gas.

FIGURE 12.—Headgear removed with left hand. Mask removed from face by grasping diaphragm assembly with right hand.

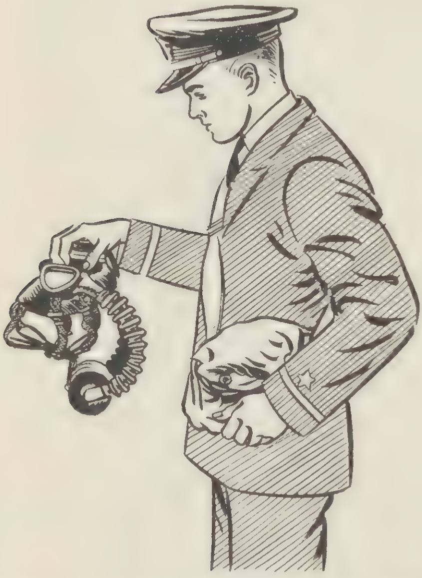


FIGURE 13.—Headgear returned to head. Mask held in front of body. Carrier brought forward to front of body.

FIGURE 14.—Opening carrier with left hand, using right hand as brace.

FIGURE 15.—Starting mask in carrier, outlet valve away from body.

FIGURE 16.—Mask replaced in carrier. Carrier closed, returned to rear of left hip.

Lift the head gear with the left hand and with the right hand grasp the diaphragm assembly. With a downward, outward, upward, backward motion, remove the facepiece. If the hat can be replaced with one hand, replace it, retaining grasp of the mask with the other hand. (If both hands are needed to replace head gear, hold the facepiece in crook of left arm while replacing head gear. Then regrasp mask with right hand by diaphragm assembly, and bring to a position in front of the body. rotating it so that the outlet valve is to the front, away from the body.)

TWO. With the left hand, bring carrier to a position in front of the left hip. With the right hand, which is holding the mask, steady carrier against hip, and with left hand, open carrier flap, and spread carrier open. Start canister in carrier with outlet valve away from body.

THREE. Push canister to bottom of carrier with the left hand. The canister should be to the rear of the carrier and well down in the bottom. The hoses should shake down easily at the sides and the facepiece settle with the diaphragm assembly in a level, horizontal position parallel to the deck. The mask is then most readily available for next use. Refasten both inner and outer flaps of the carrier, and return carrier to rear left hip. The whole gas mask drill is now completed.

As a precautionary word, remember that *in an actual gas attack*, the mask is to be put on as quickly as possible and that the breath

must be held from the time of the first detection of gas until the mask is donned, seated on the face, the facepiece cleared, and the fit tested. Therefore, it is a good idea, when you are practicing the gas mask drill by yourself, to practice putting the mask on while holding your breath. While practicing "by the numbers," it is not necessary for you to try to stop breathing.

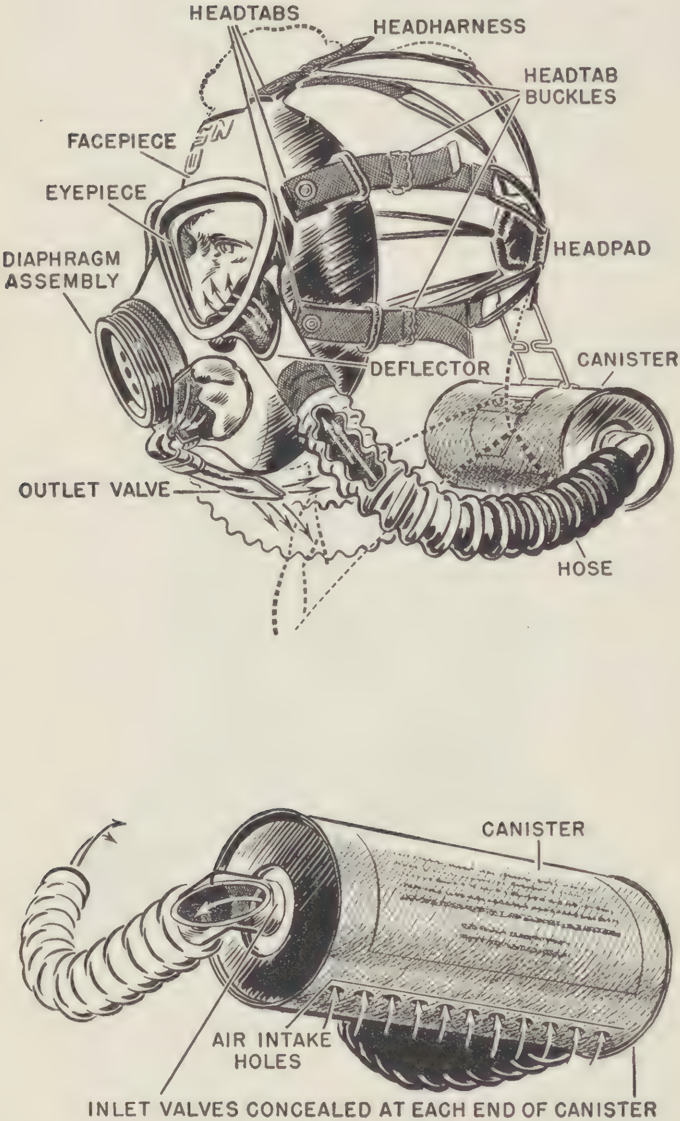
Adjustment of mask.—When you are issued a gas mask, usually you will find upon donning it and testing for fit that the mask still leaks air around the facepiece, or else that it is fitted uncomfortably tight on your face. In either case, the head harness needs adjusting so that the mask will fit snugly without undue pressure. To adjust the head harness for a correct fit of facepiece, first loosen all six straps. You will find that if you hold the head tab buckles outward at right angles to the head tab strap itself, the head harness straps may be eased through the buckles without much trouble by gently pulling them. Loosen all six head harness straps in this manner, leaving only about an inch of strap still threaded in the buckles. Put facepiece on with straps loose, and hold firmly against the chin with one hand. Center the head harness pad fairly well down on the back of the head. Adjust the top pair of straps, one at a time, by tightening evenly until the buckle lies flat. The ends of the straps should be about the same length. Adjust the middle pair, and then in the like manner the bottom pair to the same tension as the top pair of straps. Check mask to test for fit. If the mask does not fit, the top pair may be drawn up a bit tighter after smoothing mask to the face from bottom to top, or if the individual has prominent hollows at the temple, the middle pair may need further adjustment.

If the facepiece allows air to enter at this time, two possible faults are indicated:

1. If the leakage is noticed between the edges of the facepiece and the face, faulty adjustment and fitting are probable. Such a fault may be overcome by pressing the edges of the facepiece to the face, readjusting the head harness straps a little at a time. A mask adjusted too tightly may cause a channel at the edge of the facepiece through which the gas may enter, and headache and discomfort on prolonged wearing may result.

2. If adjustment of the head harness fails to stop the leak it is possible that a hole or rip in the hose, outlet valve, or facepiece may have developed, and a minute visual inspection of the gas mask is necessary. If, in order to get proper adjustment, the facepiece is uncomfortably jammed against your face, turn it in for another mask. Individual masks will vary slightly in size in spite of standard specifications.

Outlet valves occasionally stick and cause exhaled air to pass out between the facepiece and the face, especially during very cold weather or after the mask has been disinfected. In case of a sticking outlet valve, remove the facepiece and open the valve ports with a match stick or the fingers, but be careful that the valve is not injured or torn in so doing. Talcum powder sprinkled on the inner surfaces of the outlet valve will prevent further sticking. Readjust the facepiece.



NOMENCLATURE OF NAVY GAS MASK

CARE AND DISINFECTION OF THE GAS MASK

Nomenclature.

Before one can talk intelligently about any object he must first become familiar with its various parts. Let us, then, take up the nomenclature of the Navy gas mask.

First, is the *Canister.* This is the part of the mask that purifies air. Remember that it does **not** supply oxygen; it merely purifies the contaminated air of chemical warfare gases. There is one row of holes in this canister through which the air passes to enter it.

Next are the *Inlet Valves.* There are two inlet valves in this type of mask. They cannot be seen from the outside, but are at the junction of the hoses and the canister. Inlet valves are so called because it is through them that the air enters the mask from the canister.

The *Hose* is merely the connection between the canister and the facepiece, a conducting tube. The purified air passes through the two hoses and into the facepiece.

The *Facepiece* is the part of the mask that protects the face.

The *Lenses* or *Eyepieces* are provided so the wearer can see while using the mask.

The *Deflectors* are the fan-shaped tubes below the eyepieces that conduct the air from the hoses to the facepiece up over the lenses to help prevent fogging.

The *Diaphragm Assembly* is the perforated disc at the bottom of the facepiece. It contains layers of four sheets of cellophane paper for sound transmission, so that individuals wearing the mask may communicate with each other.

The *Outlet Valve* is found at the bottom of the diaphragm assembly. It is called the outlet valve because through it the exhaled air leaves the mask. The inlet and outlet valves are designed to permit air flow through the mask in only one direction: from the canister to the face, and from the face to the outside. In this way no contaminated air can get to the face without first entering the canister and being purified.

The *Head Tabs* are fastened to the sides of the facepiece. There are six of them and they fasten the head harness to the facepiece.

The *Head Harness* is the six straps that hold the facepiece against one's face.

The *Head Pad* is the joint where the six head-harness straps are united. It is seated in the center of the back of one's head.

Inspection of the Mask.

It might now be a good time to show how one may inspect his mask rapidly and at the same time, thoroughly. This is done by following the flow of air through the mask. Air enters the mask at the perforations in the canister.

Examine the canister for any punctures, dents, or rust spots. Shake it to see if its contents rattle. If the contents rattle, have the canister replaced.

Check the connection of the hoses and the elbow nozzles by pulling on them. Inspect the hoses for any holes or tears by stretching them in short sections and going over them very carefully.

Examine the connection of the hoses and the facepiece by pulling on them.

Inspect the facepiece the same way as the hose—by stretching it and looking for any holes or tears. Be sure to cover the entire facepiece and not merely a few spots here and there. Check particularly around the lenses and head tabs, places where there are attachments to the facepiece.

Check the lenses to see if they are broken or scratched in such a way as to hinder proper vision. Your mask cuts down your vision somewhat, so you do not want to increase the hindrance to vision by having defective eyepieces.

Be sure that the cellophane paper in the diaphragm assembly is not torn. If it is damaged, air will pass through it and into the facepiece and defeat the purpose of the mask.

See that the outlet valve is fastened properly to the facepiece and that it is not torn, and that there are no dust particles on the sealing surfaces. Inspect the head tabs and be sure that all six of them are attached firmly to the facepiece.

Check the head harness and be sure that it is not stretched beyond its elastic limit.

Finally, be sure that the head harness is fastened properly to the head pad.

You can see that by inspecting the mask while following the flow of air through it, there is very little danger of overlooking any of the vital parts of the mask.

Care and disinfection.

Now let us take up the care and disinfection of the gas mask. Let us start off by seeing just why it is necessary to take care of the mask. The gas mask is the chief piece of protective equipment, for it removes all of the chemical agents from any inhaled air, thereby protecting the eyes, face, and lungs from the effects of these agents. When masks are issued, they are given to individuals, and the individual becomes responsible for the care and operation of his own mask. He should

inspect it frequently and keep it in good working order at all times so he may call upon it at any time without previous warning. In order that this may be done, a certain set of rules has been established, the first of which is—

Keep Mask Dry.—This refers chiefly to the canister. If the charcoal contents get wet, they tend to cake, and contaminated air may pass through the canister and on into the facepiece without being purified. Individuals wearing the mask will then be breathing contaminated air. So in the case of a wet canister, have it replaced. If this is impossible, try to dry it carefully by leaving it in a warm room for 2 to 3 days. This is very hard to do, but it is worth a try since a wet canister is of no use.

Second, *Keep Mask and Antidim in Carrier.*—Carriers were designed for a specific purpose; namely, to carry mask and antidim. The addition of anything else will prove harmful, both to the carrier and its contents. Antidim is merely the name that is given to the material that is used to keep the eyepieces from fogging. It comes in three forms, the first of which is the stick or crayon form. This is applied by drawing the crayon across the inside of the lens and then taking the cloth and getting an even distribution of the material on the lens. This has one disadvantage in that the crayon tends to pick up dirt and when drawn across the lens, the dirt scratches it, thereby hindering proper vision. The second form is merely a paste. It comes in small tubes and is applied by squeezing a little on the finger and then rubbing it on the lens. The third and last form is simply a piece of chemically treated cloth. To use it, one moistens his fingers and wipes the lens with the wet fingers. Then the cloth is used to dry the lens. It should also be mentioned here that antidim may be applied to the outside as well as the inside of the lens. We mention the inside for that is the side of the lens that fogs up most of the time. Antidim is helped by the deflectors to keep the lenses clear. The air, in passing across the lenses, tends to keep them from fogging.

We must also state here that carriers should be taken care of. They are waterproofed, so be sure there are no holes or tears. See that the hook and eye clasp and the lift-the-dot fasteners are in good working order. If the carrier tends to mold, clean it by using a 2 per cent. acetic acid solution, or ordinary vinegar.

Third, *Handle Mask Gently.*—Masks will stand a certain amount of abuse, but you must handle them with some common sense. Do not use your mask for a pillow or a football; do not kick it around or leave it for someone to step on; and do not place it on a radiator. Remember that a single hole in the facepiece, hose, or canister may ruin the entire protection of your mask. But if you treat your mask properly, it will cause no trouble.

Fourth, *Do Not Overstretch the Head Harness.*—If this is done, the facepiece will not form a tight seal around the face, and contaminated air will be able to get into the mask. Take a little care in putting the mask on not to stretch the head harness unduly, especially when adjusting it to the face. Keep the head harness as loose as possible without losing the fit.

Fifth, *Replace Mark Properly in Carrier.*—When you are through with your mask, be sure that it is returned to the carrier in the proper manner. If this is not done, the facepiece may lose its shape or the hose may be bent in such a way as to deteriorate rather rapidly. Another good reason for replacing the mask carefully is that if you have to put the mask on in a hurry, and it is in the carrier in an improper manner, extra time will be needed before you can obtain protection. Time is very essential in dealing with gas, so it will be of advantage to you to cut it to a minimum.

Sixth, *Stow Mask Carefully.*—When masks are put away for any length of time, be sure that they are kept away from all heat, light, and moisture. Heat and light will ruin the rubber, and moisture will ruin the canister. Be sure that they are never placed more than five or six high, for the pile will be too heavy for those on the bottom and will crush them. It is an excellent practice to stuff crushed newspaper or some similar material inside of the facepiece to keep it in shape and from sticking together.

Seventh, *Inspect Mask Frequently.*—Masks should be inspected both when in use and when in stowage, for it is the only way to be sure that the mask is in proper working order. An easy and efficient way to do this is as previously explained, by following the flow of air through the mask.

Eighth, *Disinfect Mask Thoroughly.*—This is done chiefly for sanitary reasons. One should use a germicide and not an antiseptic for you want to kill the germs and not merely to numb them. In doing this, be sure that the canister is kept higher than the facepiece so that no moisture can run down the hose and on into the canister.

The old standard naval disinfectant is known as formaldehyde. It is used in a solution of five parts formaldehyde (USP) to 95 parts of water by volume. It is toxic and individuals cleaning any number of masks, especially if they are indoors, should wear a gas mask and rubber gloves. If outdoors, they might simply stand upwind from the area, but in any case it is advisable to wear a mask. To disinfect, take a damp cloth and wipe the inside of the facepiece. Then let the mask stand for 15 minutes to air. At the end of this time, take a dry cloth and dry the facepiece. If formaldehyde is used, the mask must be left to air for 12 to 24 hours, because of later toxic effects. If the mask is put on before this time, the wearer will receive a severe rash from the formaldehyde. Even though this is

the standard disinfectant, most naval stations do not use it. They have found a better substitute.

The Army's standard disinfectant is known as *roccal*. The new Navy disinfectant, standard stock NO51–D–394–78 is very similar to roccal. Two tablespoons full of the concentrated Army solution to a gallon of water will give the correct strength. Either solution A or C noted on the label of the Navy solution may be used. Neither solution is toxic, and the mask may be worn while it is still moist without any harmful effects. Many Navy stations use roccal, even though it is not standardized in the Navy.

These are the three principal disinfectants—the others we will discuss are merely substitutes. Soap and water may be used, but soap is hard to remove from the rubber facepiece. A two per cent. cresol solution may be used, but it is harmful to plastics. The eyepieces of the Mark III and IV masks are of plastic, so cresol should not be used on these masks. It may be used on the Mark I and II, where the eyepieces are of glass. An 0.3 to 3 per cent. copper sulfate solution may be used, but, like soap, it is hard to remove from the rubber facepiece. The 70 per cent. alcohol solution is for Navy civilian masks only. In training civilian personnel, we need a disinfectant that will work rapidly and thoroughly. It appears that the 70 percent alcohol solution is the answer to the problem. It is not used as the standard disinfectant for all masks, chiefly because of its expense.

Now that the rules for the care and disinfection of the gas mask have been discussed, let us consider the lives of the various canisters. The canister on the Marks I and II will last for about 40 hours; on the Marks III and IV for about 13½ hours; on the Navy civilian mask for about 8 hours. These figures are approximate, for there is no definite time limit that can be depended upon under all circumstances. The figures are based on continued use in the normal field concentration of war gases. Canister life depends upon the agent, the concentration, and the time of exposure. One way to test a mask is by wearing it in a gas chamber. If it is very hard to breathe through or if gas comes through the canister, the canister should be replaced. Here you should be warned that all major repairs must be done by *experienced* personnel.

In closing, let us briefly review the rules for the care of the gas mask:

1. **Keep mask dry.**
2. **Keep mask and antidim in carrier.**
3. **Handle mask gently.**
4. **Do not overstretch the head harness.**
5. **Replace mask properly in carrier.**
6. **Stow mask carefully.**
7. **Inspect mask frequently.**
8. **Disinfect mask thoroughly.**

MATÉRIEL AND TACTICS

Possibilities of Chemical Attack.

You are already familiar with the fact that the ultimate objective of naval combat is to sink the enemy ships. Naturally, chemical weapons are unable to accomplish this objective by themselves. However, it is believed that chemicals can be used to increase the effect of high explosive munitions. The extensive use of the airplane in the present war has established the belief that if chemical warfare is initiated, chemicals can be expected in every air attack at sea.

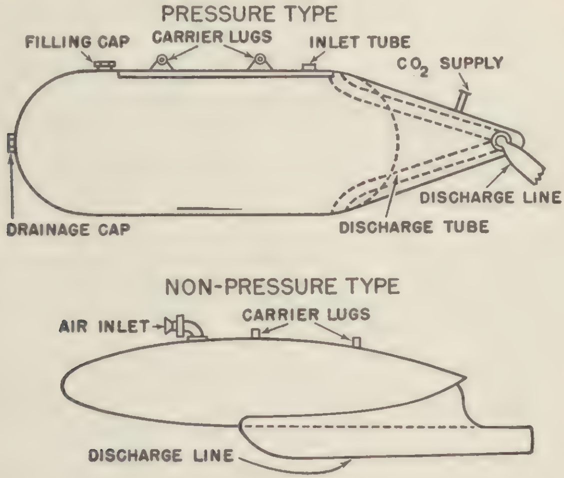
The use of chemicals against a fighting ship will reduce the accuracy and firepower of the ship by harassing or injuring the gun crews and exposed personnel. This is especially true of antiaircraft batteries. Chemicals can also be used to harass damage control parties and in this way slow up repair work on damage caused by high explosive shells (HE). However, there are several features of both naval and chemical attack which limit and make chemical warfare difficult.

For a chemical attack to be successful, hits must be scored on the target as in a high explosive attack. The shell or bomb must hit the target, detonate, and spread the chemical agent over the personnel or equipment you wish to neutralize. Naturally, such accuracy is made more difficult by the size and motion of a naval target. In addition to these usual characteristics of naval conflict, there are other difficulties which are inherent in chemical warfare itself. Many chemical agents react with the metal of the munition and cause leaks, in which case the munition and filling must be destroyed. To resist this corrosive action of the chemical agents, either heavier gauge metal or a chemical-resistant lining is added to the munition. The weight added in this way reduces the chemical efficiency or amount of agent which can be dispersed by the munition. Then, the characteristics of many of the agents themselves render them useless for naval combat. Many of them are unstable to detonation—that is, the heat created by the detonation of the explosive charge causes the chemical to break down into harmless substances—others are easily neutralized by water. Lewisite is an example of this type. Upon contact with water, or even on an extremely humid day, Lewisite forms a solid arsenical compound which is vesicant, but can easily be washed away. Most of the nonpersistent agents would be ineffective at sea under normal conditions of use because of the relatively high wind velocities which are usually found there.

You know from your study of agents that blister gas casualties are not apparent for a period of 2 to 15 hours after contamination. It must be noted however that the new nitrogen mustards will produce their eye effects in about 10 minutes. Until the latent period

of these chemicals has passed and the blistering action has taken place, the contaminated personnel can fight just as efficiently as the uncontaminated personnel. In a period of that length, a naval battle may be easily won or lost and the blister gas will have had no effect on the outcome. For that reason, attack by blister gas will be made at least 12 hours ahead of the actual battle. Of course any of the nonpersistent agents can be used for their immediate effect.

Chemical agents can be dispersed by airplane spray tanks, bombs, or shells from ships' guns.



Aircraft Spray.

There are two main types of **spray tanks**—pressure and nonpressure. The nonpressure tank is of simple, light, inexpensive construction and produces a spray of fine droplets. The nonpressure tanks rely on the speed of the plane and the flow of air through the tank to disperse the agent. The air enters a small inlet tube on top of the tank, flows into the tank, and pushes the agent out the discharge line in the rear. Both the inlet and discharge lines are opened from the cockpit. However, there is no means of stopping the discharge once it is started. The disadvantage of this feature to the Navy is evident—in order to hit the target it is necessary to spray only a small area. If the nonpressure type tank is used, only one run may be made on the target and a large part of the agent is washed on the open sea. The pressure type spray tank uses carbon dioxide pressure, supplied by a cylinder in the plane, to spray the agent. In this way, the pilot may start and stop the spray at will from the cockpit and make several runs on the target before the tank is emptied. Another advantage of the pressure tank over the nonpressure tank is that the agent is dispersed in larger drops. These large size drops are less affected by the wind and also have a greater casualty effect

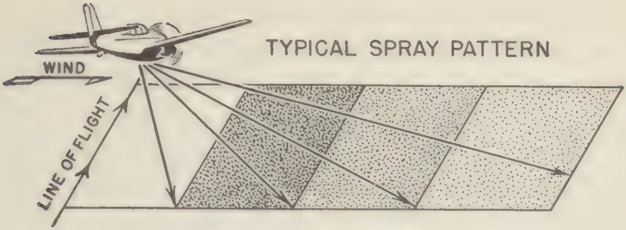
on contact with the skin. The pressure tank is of heavy construction to stand the 70 pounds carbon dioxide pressure. It is usually made of Monel metal and is rather expensive. The discharge line runs from the rear of the tank and may be raised or lowered depending on the carrying position of the tank. It may be carried on the wings, on the bottom of the fuselage, or in the bomb-bay.

Mustard and tear gas, in addition to the smoke agents, can be sprayed. Mustard spray is made up of relatively large drops which are not greatly affected by wind and also create a greater degree of contamination. Tear gas spray is very fine and subject to wind action. Since the freezing point of mustard is rather high, mustard tends to freeze in a spray tank if the plane flies at even moderate altitudes for a period of several hours. To prevent freezing, a mixture of mustard and Lewisite is used. This mixture has a very low freezing point and overcomes the freezing difficulty. The tanks may also be wrapped with an insulating material to keep the mustard from freezing.

High altitude spray; that is, 20,000 feet or above, which could be delivered without the knowledge of the enemy, would be ideal. But this type of spraying is difficult since it takes the spray a comparatively long time (20 minutes or more) to reach the target and it is very hard to release a chemical agent so that it will fall on the spot where the target will be 20 minutes later. Experience will probably show that a better method is to include a number of spray tank equipped planes in a preliminary air attack. This combination of chemical and high explosive would serve several purposes: (1) the combination might surprise the enemy, (2) if a sufficient concentration of agent is laid down, the enemy would be forced to cease firing long enough to protect themselves from gas and such action would leave the ship open to uncontested bomb or torpedo attack, (3) the chemical agent might not be detected since the odors created by explosives very often mask the odor of the agent.

The second statement deserves a brief added comment. It is the policy of our Navy never to use protective equipment if such use will in any way reduce the fighting efficiency of the ship. In other words, in case of an attack by gas our men would not stop fighting in order to put on their masks. However, if a high enough concentration of tear gas, for example, is laid down on exposed men, they will be physically unable to operate their guns accurately. This is the type of concentration which must be laid down to gain the advantage.

Airplane spray always falls in the same pattern. The pattern is divided into three sections. Each section farther from the plane has slightly smaller drops than the preceding one. The section closest to the plane is of course made up of the largest drops. The pilot attempts to get this section on the target since it will produce the



greatest contamination. The width of the pattern will vary with the altitude of the plane and the wind direction and speed.

Chemical bombs.

As has already been mentioned, the corrosive action of agents on metals requires that chemical bombs be made of heavier gauge metal than would ordinarily be used. The present trend is to drop large numbers of small bombs filled with blister gas to give a wide dispersion of the agent. Blister gases are thought to be the only agents which can be effectively dispersed by bombs on sea targets. However, work is going on at the present time which seems to indicate that nonpersistent agents may be very effectively dispersed in very large size bombs.

Chemical bombs will be used in much the same manner as spray. That is—blister gas bombs before a battle and nonpersistent agents during the attack. Bombs are especially useful in creating a heavy contamination at a particular point, while spray produces a more or less uniform contamination over an entire area. It may be desirable to heavily contaminate a particular antiaircraft battery or superstructure already wrecked by high explosive.

Chemical shells.

Chemical shells are the last main division of chemical warfare weapons. The Navy has a 5-inch white phosphorus smoke shell. This shell is a base ejection type which bursts in the air and creates the smoke cloud as the white phosphorus falls through the air. The air burst feature of the shell makes it useful over water as well as over shore installations. The screen is easily shifted or maintained by firing additional rounds.

The white phosphorus smoke shells will, of course, be used to create the usual type smoke screen on the enemy to hamper his accuracy, to screen the movements of our own ships, either offensively or defensively, or to protect especially vulnerable ships of the fleet. It is thought that this smoke shell will be very useful in landing operations. With this shell the enemy shore batteries could be covered by smoke regardless of the wind direction. The smoke cloud would prevent the batteries from firing accurately and so minimize the casualties of the beach operation. This WP shell can also be used

for its casualty effect. As a result of its use in the invasion of Sicily, it was discovered that serious casualties were produced very quickly and in addition there was a great degree of surprise in the attack.

The only other chemical shell being considered by the Navy is an armor-piercing shell with a small amount of tear gas in it. You have already been told that tear gas is a nonpersistent agent. This is true under field conditions where only the vapor is encountered. However, when tear gas is released in a closed compartment, the high vapor concentration, set up by the heat of detonation, immediately recondenses on the bulkheads to solid chloracetophenone. After the solid particles are formed, they start their normal process of vaporization again. The vapor is given off in sufficient concentration to force anyone entering the compartment to wear a mask for a period of hours or days depending on the size of the compartment and ventilation.

The expected use of paritally chemical-filled armor-piercing shells differs quite a bit from that of spray or bombs. Naturally, all the personnel in a compartment in which an AP (armor-piercing shell) bursts will be killed and the compartment will be damaged by the high explosive. The tear gas vapor released on detonation will condense on the bulkheads and then continue to give off a harassing concentration for some time. The presence of this gas will force any repair parties working in the compartment to wear masks. Masks reduce the efficiency of anyone so you can see that it will take the repair party longer to restore the watertight integrity of the ship. In this way the effect of high explosive can be increased.

Now to consider how the Navy can actually use chemicals. Probably the most extensive use will be against shore installations. In deciding to use a persistent or nonpersistent agent, one important question must be decided. "Do we want to take the area or merely deny it to the enemy?" If we want to drive the enemy out and not take possession of the area ourselves, we will use a persistent agent like mustard; use any means possible to lay it down as quickly and as heavily as possible. This will either force the enemy to leave the area or take a lot of casualties—in any event the enemy is denied the use of the area.

On the other hand, if we want to move into the area ourselves soon after the chemical attack, we must use some nonpersistent agent or suffer casualties ourselves from a persistent agent. The gas should be laid down at least a half hour before the intended attack so that all of the agent will have been dispersed before our own men arrive. In this way we get all the good effects of the gas by making casualties of some of the enemy troops and at the same time have no worries

about any danger to our own men. The many beach operations necessary in this war offer effective uses of chemicals.

Summary.

In summary then it may be said that naval chemical warfare can be an effective aid to high-explosive attack at sea. The agents may be used to neutralize the enemy's fire power in preparation for an HE attack, or to hamper the control of damage inflicted by HE. All of the chemical munitions can be used to good advantage under a capable commander who understands both the advantages and limitations of chemical warfare.

DECONTAMINATION

Decontamination is the term applied to the process of removing or destroying chemical agents from either personnel or matériel. This short discussion is designed to present to you the basic principles of both ship and shore clean-up of these chemicals.

Analysis of problem at sea. Let us analyze just what the situation at sea is going to be. As you know, the use of chemicals is considered possible against ships, although there is some discussion as to how effective it would be in view of natural defenses of a ship at sea.

The WIND, the first of these defenses, has a twofold effect on the use of chemical agents. The direction and velocity of the wind of course complicate the problem of placing the agent on a vessel. This is particularly true in the case of spray and the problem becomes increasingly difficult with altitude because of the variance of winds at different levels.

The second effect of the wind is to act as a dilutent and decontaminant. Except in the case of very persistent agents, the combination of the natural wind at sea and wind made by the movement of the ship sweeps away the vapors in a short time, thereby decreasing their potential effectiveness.

The second of the natural defenses is the MOVEMENT of the ship. A ship is a comparatively small target, and on an irregular course, such as would be pursued during air attack, would offer a very difficult target.

The third defense is the WATER. There is no such thing as a successful near miss in chemical warfare. The water either hydrolyzes or so dilutes the agent that any part not directly landing on the ship has no effect.

The last of the natural defenses is that of COVER. Under battle conditions, the ship will be cruising with all possible ventilation turned off, and the ship will offer the maximum in the way of fume-tight integrity. Therefore, a very large percentage of personnel which is below decks would not be exposed to the agents. Those topside will be provided with protective equipment and may also be relieved in time to decontaminate themselves if they are subjected to these chemical agents.

Taking into account these natural defenses, the Navy still believes that attack may come in one of three forms:

1. Vesicant spray discharged from aircraft.
2. Chemicals in armor-piercing projectiles.
3. Chemical bombs.

Although a ship at sea has natural defenses, it also has one very distinct disadvantage. It is a compact fighting unit, and almost every part of it could be considered a vital area. Therefore, it must be decontaminated despite the concentration or extent of contamination. An area cannot generally be evacuated as is possible in the case of a shore establishment. The men must continue to sleep, eat, and fight, so decontamination must proceed as soon and as quickly as is possible, depending on the tactical situation.

For this decontamination, we must have special agents. They must be agents which can be stowed for considerable lengths of time aboard ships without decomposing under the conditions that may be expected there. They must also be noncorrosive as there is a great deal of relatively sensitive matériel aboard which would be ruined by rusting. Chloride of lime, a common decontaminating agent, fails for use at sea, as it deteriorates on storage, and has bad effect both on metals and clothing.

Procedure Against Nonpersistent Agents

As we have seen, the natural wind at sea sweeps away most of these agents so they present a very small problem insofar as decontamination is concerned. If by chance they should get below decks, personnel must resort to the gas mask until sufficient ventilation can be provided to carry away the vapors.

Procedure Against the Lacrimators.

Although the lacrimators or tear-causing gases are generally classified as nonpersistent agents, their effects will extend over a much longer period if they are present in liquid or solid form. Therefore it is necessary to have a special procedure to deal with these gases.

Ventilation.—Proper ventilation, involving large quantities of air, can be depended upon to remove CN in the gaseous form from interior compartments in a few hours. Such gases might be drawn in from tear gas deposited upon the upper decks by spray or bombs. In any event, and regardless of how the CN penetrated to the interior, every effort should be made to isolate the contaminated compartments and ventilate them with all available means. This may be accomplished by building up a positive pressure in the compartments surrounding the contaminated one, and exhausting it directly to the weather.

Flooding.—The wearing of masks by personnel engaged in such activities as antiaircraft gunnery causes a serious loss in efficiency. Therefore we must have a means of dealing with tear gas which will allow men to go about their ordinary tasks without resorting to individual protection. This method is by flooding. If tear gas is sprayed on the ship, the concentration on the weather decks can be temporarily greatly reduced by prompt hosing, followed by keeping the contaminated area wet with water. The water does not destroy the CN, but the hose mechanically washes away a large percentage and the film of water over the CN prevents the air from reaching it and thereby prevents its vaporizing. However, after a contaminated area has been so treated and allowed to dry, there usually is enough CN left to set up a lacrimatory concentration. Therefore, hosing is at the most a temporary measure. It should also be pointed out that there would scarcely be enough hoses available to cover all the topside area that might be contaminated by a CNS spray or bomb. This method, however, may find application in an enclosed compartment.

Decontamination Procedure Against Mustard

Our real primary interest in regard to decontamination is the procedure against mustard. It is the most insidious of the known agents. Mustard in liquid form penetrates rapidly into ordinary clothing, paintwork, wood, canvas, and practically all material and surfaces, except unpainted metal and glass, and is capable of producing casualties for a long period of time.

The decontamination agent.

Based on the requirements of stable stowage at sea and noncorrosive action upon matériel, the Navy has selected as the active agent for decontamination aboard ship, RH–195. It is a creamy white powdered compound which releases active chlorine on contact with mustard or other vesicants and thereby neutralizes them.

To dissolve and spread the RH–195, which is not soluble in water, a solvent known as acetylene tetrachloride (or tetrachlorethane) is provided. This solvent is a colorless liquid which is stable for indefinite periods. It is noninflammable, but gives off fumes which are obnoxious and which, if inhaled to any great extent, are poisonous. Continuous physical contact with the solvent (either inhalation of the fumes or physical contact with the liquid), produces an accumulative toxic effect on the liver. However, the gas mask gives complete protection against the fumes and if the hands are protected against contact with the liquid by wearing rubber gloves, there should be no difficulty encountered in the handling of this liquid.

The RH–195 solution is made up by mixing 1 part of the RH–195 with 4 parts of the solvent by *volume*, or 1 part to 10 by *weight.* It should be mixed topsides in any metal drum or container and should be stirred on mixing for at least 5 minutes. If it is to be applied by spraying, the solution should be poured through two thicknesses of cheesecloth or a strainer of similar mesh.

Application.—One gallon of this solution will effectively decontaminate 15 square yards of heavily contaminated area, 30 square yards of moderately contaminated area, and a much larger area which has been lightly contaminated.

Small hand sprayers, of 3-gallon capacity, are being issued, by means of which the decontaminating solution may be applied. However, since it is necessary for the solution to be scrubbed in to bring the active agent into contact with the liquid vesicant, it is found that the solution can be just as easily applied by brooms and swabs, using an ordinary pail for a container.

Decontamination squads should always be equipped with full protective clothing and masks. As for decontamination procedure, always start at the upper limit of the area involved on vertical surfaces and work downward, so that the full benefit of any run-off may be obtained. The clean-up should always start at the edges of the contaminated areas, either vertical or flat, in order to avoid the risk of contaminating the working parties. As applied, the solution should be thoroughly scrubbed in with brooms or swabs in order that the solution be brought into intimate contact with the mustard. Scrubbing should continue for at least 5 minutes. After this, the area may be washed down with a hose. In decontaminating wooden decks, at least 30 minutes of scrubbing is essential before washing down.

The order in decontamination procedure will differ depending on the type of ship, its organization, and the extent of the contamination. Among the important items that must be the first taken care of are the following:

1. *Navigation equipment*—everything necessary for the safe handling of the ship.
2. *Communication equipment*—that necessary to coordinate various battle stations and various units of a force.
3. *Ordance matériel*—particularly antiaircraft batteries.
4. *Damage control gear*—this includes such things as fire-fighting apparatus that must be available in case of mishap.
5. *Vital topside areas*—such as those surrounding important battle stations and affording access between them.

Decontamination Procedure Ashore

Let us look briefly to the shore station problem. A shore station is much more vulnerable to chemical attack as it lacks the natural defenses of a ship at sea. The plan for defense will differ greatly, of course, depending upon the location and function of the activity. However, in general, a shore base is fortunate in that plans may be made to evacuate at least part of the more heavily contaminated areas if they are not immediately needed. Provisions must also be made to clean up rather large areas of a vital nature, such as roadways, runways, taxiing areas, etc.

Where ships are present or there is matériel similar to that carried aboard ship, the procedure will be the same as that at sea, using the same material and methods.

When it comes to the cleaning up of large areas where corrosion is not a problem, it is possible to use bleach (chloride of lime) rather than the RH–195 solution. This bleach may be used in either of two forms. The first is dry mix. This means that the lime is mixed with 2 parts to 3 parts by volume of earth and spread over the contaminated surface and left there for a period of 24 hours.

A quicker and more effective means of using this bleach is in a slurry made up of 50 per cent. bleach and 50 per cent. water by weight. For large areas this material is spread by use of a 400 gallon mobile decontaminating unit. This consists of a 400 gallon wooden tank mounted on a 2½ ton truck. It is equipped with the necessary pump and lines to supply the slurry at the rate of 20 gallons per minute at a working pressure of 400 psi to the nozzles. The men manning the nozzles can ride on the forward part of the truck and spray a pathway in front of them approximately 13 feet wide and a quarter of a mile long in about 18 minutes.

There is also a smaller unit of 150 gallons capacity. It is capable of pumping 10 gallons per minute at 400 psi pressure and has one nozzle. It is very mobile, being mounted on a two-wheel trailer towed by a jeep. A gasoline engine attached furnishes the power for the pump. The Navy favors this 150-gallon unit over the 400-gallon one because of its ease and maneuverability in handling.

Conclusion

In the time available it has been possible to merely outline the principles and procedures involved, but the application by trained men will allow any ship or station to return to its maximum fighting efficiency in the shortest possible time and with a minimum of casualties.

DECONTAMINATING MIXTURES

D. A. N. C.

Dry Mix

Chloride of Lime and Dirt
2 shovels : 3 shovels
Mix thoroughly, work in well

Slurry

Chloride of Lime and Water
5 shovels : 1 pail (3 gal.)
Stir up vigorously and thoroughly.
Brush in well.

Paste:

Chloride of Lime and Water
Mix to thickness
of wallpaper paste.
Spread evenly
and thoroughly.

D. A. N. C. (Decontaminating Agent
Noncorrosive)
1 qt. powder to 4 qts. solvent
or
D. A. N. C. paste or powder mixed
with water as directed.
(Do not use on plastics such as
airplane cockpit covers.)

NOTE.—For light contamination you can use less chloride of lime, more dirt or water, if you spread the mixture and work it in thoroughly.

For EMERGENCY DECONTAMINATION of weapons, personal equipment or person, use S-461 Ointment.

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